



**CHEMISTRY
HIGHER LEVEL
PAPER 1**

Thursday 10 May 2007 (afternoon)

1 hour

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- The periodic table is provided for reference on page 2 of this examination paper.

The Periodic Table

1	2	3	4	5	6	7	0											
<div>1 H 1.01</div>	<div>Atomic Number</div> <div>Element</div> <div>Atomic Mass</div>						<div>2 He 4.00</div>											
	<div>3 Li 6.94</div>	<div>4 Be 9.01</div>					<div>9 F 19.00</div>											
	<div>11 Na 22.99</div>	<div>12 Mg 24.31</div>					<div>18 Ar 39.95</div>											
	<div>19 K 39.10</div>	<div>20 Ca 40.08</div>	<div>21 Sc 44.96</div>	<div>22 Ti 47.90</div>	<div>23 V 50.94</div>	<div>24 Cr 52.00</div>	<div>25 Mn 54.94</div>	<div>26 Fe 55.85</div>	<div>27 Co 58.93</div>	<div>28 Ni 58.71</div>	<div>29 Cu 63.55</div>	<div>30 Zn 65.37</div>	<div>31 Ga 69.72</div>	<div>32 Ge 72.59</div>	<div>33 As 74.92</div>	<div>34 Se 78.96</div>	<div>35 Br 79.90</div>	<div>36 Kr 83.80</div>
<div>37 Rb 85.47</div>	<div>38 Sr 87.62</div>	<div>39 Y 88.91</div>	<div>40 Zr 91.22</div>	<div>41 Nb 92.91</div>	<div>42 Mo 95.94</div>	<div>43 Tc 98.91</div>	<div>44 Ru 101.07</div>	<div>45 Rh 102.91</div>	<div>46 Pd 106.42</div>	<div>47 Ag 107.87</div>	<div>48 Cd 112.40</div>	<div>49 In 114.82</div>	<div>50 Sn 118.69</div>	<div>51 Sb 121.75</div>	<div>52 Te 127.60</div>	<div>53 I 126.90</div>	<div>54 Xe 131.30</div>	
<div>55 Cs 132.91</div>	<div>56 Ba 137.34</div>	<div>57 † La 138.91</div>	<div>72 Hf 178.49</div>	<div>73 Ta 180.95</div>	<div>74 W 183.85</div>	<div>75 Re 186.21</div>	<div>76 Os 190.21</div>	<div>77 Ir 192.22</div>	<div>78 Pt 195.09</div>	<div>79 Au 196.97</div>	<div>80 Hg 200.59</div>	<div>81 Tl 204.37</div>	<div>82 Pb 207.19</div>	<div>83 Bi 208.98</div>	<div>84 Po (210)</div>	<div>85 At (210)</div>	<div>86 Rn (222)</div>	
<div>87 Fr (223)</div>	<div>88 Ra (226)</div>	<div>89 ‡ Ac (227)</div>																
†																		
<div>58 Ce 140.12</div> <div>59 Pr 140.91</div> <div>60 Nd 144.24</div> <div>61 Pm 146.92</div> <div>62 Sm 150.35</div> <div>63 Eu 151.96</div> <div>64 Gd 157.25</div> <div>65 Tb 158.92</div> <div>66 Dy 162.50</div> <div>67 Ho 164.93</div> <div>68 Er 167.26</div> <div>69 Tm 168.93</div> <div>70 Yb 173.04</div> <div>71 Lu 174.97</div>																		
‡																		
<div>90 Th 232.04</div> <div>91 Pa 231.04</div> <div>92 U 238.03</div> <div>93 Np (237)</div> <div>94 Pu (242)</div> <div>95 Am (243)</div> <div>96 Cm (247)</div> <div>97 Bk (247)</div> <div>98 Cf (251)</div> <div>99 Es (254)</div> <div>100 Fm (257)</div> <div>101 Md (258)</div> <div>102 No (259)</div> <div>103 Lr (260)</div>																		

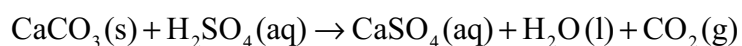
1. On complete combustion, a sample of a hydrocarbon compound produces 1.5 mol of carbon dioxide and 2.0 mol of water. What is the molecular formula of this hydrocarbon?

- A. C_2H_2
- B. C_2H_4
- C. C_3H_4
- D. C_3H_8

2. When excess $BaCl_2(aq)$ was added to a sample of $Fe(NH_4)_2(SO_4)_2(aq)$ to determine the amount in moles of sulfate present, 5.02×10^{-3} mol of $BaSO_4$ was obtained. How many moles of sulfate ions and iron ions were in the sample of $Fe(NH_4)_2(SO_4)_2$?

	Amount of sulfate ions / moles	Amount of iron ions / moles
A.	5.02×10^{-3}	2.51×10^{-3}
B.	10.04×10^{-3}	5.02×10^{-3}
C.	2.51×10^{-3}	5.02×10^{-3}
D.	10.04×10^{-3}	2.51×10^{-3}

3. What volume of $0.500 \text{ mol dm}^{-3}$ sulfuric acid solution is required to react completely with 10.0 g of calcium carbonate according to the equation below?



- A. 100 cm^3
- B. 200 cm^3
- C. 300 cm^3
- D. 400 cm^3

4. A transition metal ion X^{2+} has the electronic configuration $[\text{Ar}]3d^9$. What is the atomic number of the element?
- A. 27
 - B. 28
 - C. 29
 - D. 30
5. Which statements are correct for the emission spectrum of the hydrogen atom?
- I. The lines converge at lower energies.
 - II. Electron transitions to $n = 1$ are responsible for lines in the UV region.
 - III. Lines are produced when electrons move from higher to lower energy levels.
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
6. Which statement is correct for the halogen group?
- A. Halide ions are all reducing agents, with iodide ions being the weakest.
 - B. Halogens are all oxidizing agents, with chlorine being the strongest.
 - C. Chloride ions can be oxidized to chlorine by bromine.
 - D. Iodide ions can be oxidized to iodine by chlorine.

7. Which of the following statements are correct?

- I. The melting points decrease from Li \rightarrow Cs for the alkali metals.
- II. The melting points increase from F \rightarrow I for the halogens.
- III. The melting points decrease from Na \rightarrow Ar for the period 3 elements.

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

8. The compound $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ is isomeric with the compound $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$. What is the oxidation state of cobalt in these compounds?

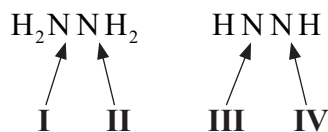
	$[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$	$[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$
A.	+3	+3
B.	+2	+1
C.	+3	+2
D.	+2	+3

9. When C_2H_4 , C_2H_2 and C_2H_6 are arranged in order of **increasing** C–C bond length, what is the correct order?

- A. C_2H_6 , C_2H_2 , C_2H_4
- B. C_2H_4 , C_2H_2 , C_2H_6
- C. C_2H_2 , C_2H_4 , C_2H_6
- D. C_2H_4 , C_2H_6 , C_2H_2

10. Which compound contains **both** ionic and covalent bonds?
- A. MgCl_2
 - B. HCl
 - C. H_2CO
 - D. NH_4Cl
11. When the species BF_2^+ , BF_3 and BF_4^- are arranged in order of **increasing** $\text{F}-\text{B}-\text{F}$ bond angle, what is the correct order?
- A. BF_3 , BF_4^- , BF_2^+
 - B. BF_4^- , BF_3 , BF_2^+
 - C. BF_2^+ , BF_4^- , BF_3
 - D. BF_2^+ , BF_3 , BF_4^-
12. Which molecule is square planar in shape?
- A. XeO_4
 - B. XeF_4
 - C. SF_4
 - D. SiF_4

13. What is the hybridization of nitrogen atoms I, II, III and IV in the following molecules?

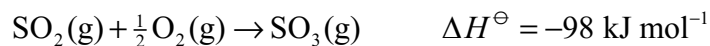


	I	II	III	IV
A.	sp^2	sp^2	sp^3	sp^3
B.	sp^3	sp^3	sp^2	sp^2
C.	sp^2	sp^2	sp	sp
D.	sp^3	sp^3	sp	sp

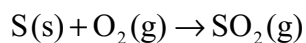
14. 1 mole of hydrogen, 2 moles of oxygen and 3 moles of carbon dioxide are placed in a closed container at 298 K. What is the ratio of **average** kinetic energies of each gas under these conditions?

- A. 1 : 2 : 3
 B. 3 : 2 : 1
 C. 1 : 1 : 1
 D. 1 : 2 : 1

15. Consider the following reactions.



What is the ΔH^\ominus value (in kJ mol^{-1}) for the following reaction?



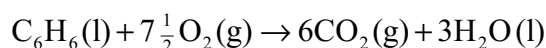
- A. -297
 B. +297
 C. -493
 D. +493

16. Which statement is correct for an endothermic reaction?

- A. Bonds in the products are stronger than the bonds in the reactants.
- B. Bonds in the reactants are stronger than the bonds in the products.
- C. The enthalpy of the products is less than that of the reactants.
- D. The reaction is spontaneous at low temperatures but becomes non-spontaneous at high temperatures.

17. Consider the following information.

Compound	C ₆ H ₆ (l)	CO ₂ (g)	H ₂ O(l)
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	+49	–394	–286



Which expression gives the correct value of the standard enthalpy change of combustion for benzene (l), in kJ mol^{–1}?

- A. $12(-394) + 6(-286) - 2(49)$
- B. $12(394) + 6(286) - 2(-49)$
- C. $6(-394) + 3(-286) - (49)$
- D. $6(394) + 3(286) - (-49)$

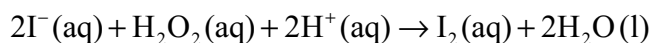
18. Which equation represents the lattice enthalpy of magnesium oxide?

- A. $\text{Mg}(\text{s}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{MgO}(\text{s})$
- B. $\text{Mg}^{2+}(\text{g}) + \text{O}^{2-}(\text{g}) \rightarrow \text{MgO}(\text{g})$
- C. $\text{Mg}^{2+}(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{MgO}(\text{s})$
- D. $\text{Mg}^{2+}(\text{g}) + \text{O}^{2-}(\text{g}) \rightarrow \text{MgO}(\text{s})$

19. At 25 °C, 100 cm³ of 1.0 mol dm⁻³ hydrochloric acid is added to 3.5 g of magnesium carbonate. If the sample of magnesium carbonate is kept constant, which conditions will **not** increase the initial rate of reaction?

	Volume of HCl / cm ³	Concentration of HCl / mol dm ⁻³	Temperature / °C
A.	200	1.0	25
B.	100	2.0	25
C.	100	1.0	35
D.	200	2.0	25

20. Consider the reaction



In the presence of S₂O₃²⁻(aq) and starch solution, the time taken for a blue colour to form was observed at various reactant concentrations.

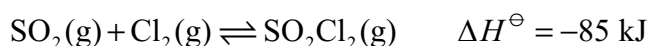
Experiment	[I ⁻] / mol dm ⁻³	[H ₂ O ₂] / mol dm ⁻³	[H ⁺] / mol dm ⁻³	Time / s
1	0.10	0.12	0.01	25
2	0.05	0.12	0.01	50
3	0.10	0.06	0.01	100

What is the correct order with respect to I⁻ and H₂O₂?

	I ⁻	H ₂ O ₂
A.	1	2
B.	$\frac{1}{2}$	$\frac{1}{4}$
C.	2	1
D.	2	4

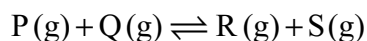
21. Which statement is correct with regard to the catalysed and uncatalysed pathways for a given reaction?
- A. The enthalpy change of the catalysed reaction is less than the enthalpy change for the uncatalysed reaction.
 - B. The enthalpy change of the catalysed reaction is greater than the enthalpy change for the uncatalysed reaction.
 - C. The enthalpy change of the catalysed reaction is equal to the enthalpy change for the uncatalysed reaction.
 - D. The activation energy of the catalysed reaction is greater than the activation energy for the uncatalysed reaction.

22. Consider the following equilibrium reaction in a closed container at 350 °C.



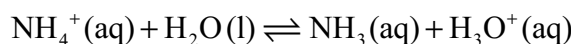
Which statement is correct?

- A. Decreasing the temperature will increase the amount of $\text{SO}_2\text{Cl}_2(\text{g})$.
 - B. Increasing the volume of the container will increase the amount of $\text{SO}_2\text{Cl}_2(\text{g})$.
 - C. Increasing the temperature will increase the amount of $\text{SO}_2\text{Cl}_2(\text{g})$.
 - D. Adding a catalyst will increase the amount of $\text{SO}_2\text{Cl}_2(\text{g})$.
23. A 1.0 dm³ reaction vessel initially contains 6.0 mol of **P** and 6.0 mol of **Q**. At equilibrium 4.0 mol of **R** is present. What is the value of K_c for the following reaction?



- A. 0.11
- B. 0.25
- C. 0.44
- D. 4.00

24. Solutions of hydrochloric acid (HCl(aq)) and ethanoic acid ($\text{CH}_3\text{COOH(aq)}$) of the same concentration reacted completely with 5.0 g of calcium carbonate in separate containers. Which statement is correct?
- A. $\text{CH}_3\text{COOH(aq)}$ reacted slower because it has a lower pH than HCl(aq) .
- B. A smaller volume of $\text{CO}_2(\text{g})$ was produced with $\text{CH}_3\text{COOH(aq)}$ than with HCl(aq) .
- C. A greater volume of $\text{CO}_2(\text{g})$ was produced with $\text{CH}_3\text{COOH(aq)}$ than with HCl(aq) .
- D. The same volume of $\text{CO}_2(\text{g})$ was produced with both $\text{CH}_3\text{COOH(aq)}$ and HCl(aq) .
25. Ammonia (NH_3) is a weak base in aqueous solution with an ionization constant K_b . What expression is equal to the ionization constant for the following reaction?



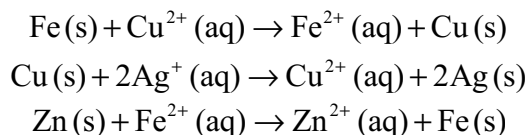
- A. $\frac{K_w}{K_a}$
- B. $\frac{K_a}{K_w}$
- C. $\frac{K_w}{K_b}$
- D. $\frac{K_b}{K_w}$
26. The pK_a values of four acids are as follows.

W	4.87
X	4.82
Y	4.86
Z	4.85

What is the correct order when these acids are arranged in order of **increasing** acid strength?

- A. X, Z, Y, W
- B. X, Y, Z, W
- C. W, Z, Y, X
- D. W, Y, Z, X

27. 10 cm³ of 0.01 mol dm⁻³ nitric acid (HNO₃) is diluted with 90 cm³ of water. What is the pH of the resulting solution?
- A. 1
- B. 2
- C. 3
- D. 4
28. A base of concentration 0.10 mol dm⁻³ is titrated with 25 cm³ of an acid of concentration 0.10 mol dm⁻³. Which base-acid pair would have the highest pH at the equivalence point?
- A. NaOH(aq) and CH₃COOH(aq)
- B. NaOH(aq) and HNO₃(aq)
- C. NH₃(aq) and HNO₃(aq)
- D. NH₃(aq) and CH₃COOH(aq)
29. Consider the following spontaneous reactions.



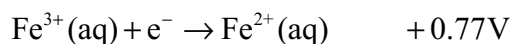
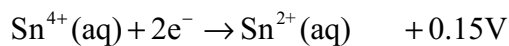
Which is the correct combination of strongest oxidizing agent and strongest reducing agent?

	Strongest oxidizing agent	Strongest reducing agent
A.	Ag(s)	Zn(s)
B.	Ag ⁺ (aq)	Zn(s)
C.	Zn ²⁺ (aq)	Ag(s)
D.	Zn(s)	Ag ⁺ (aq)

30. Which statement is correct?

- A. Spontaneous redox reactions produce electricity in an electrolytic cell.
- B. Electricity is used to carry out a non-spontaneous redox reaction in a voltaic cell.
- C. Oxidation takes place at the negative electrode in a voltaic cell and the positive electrode in an electrolytic cell.
- D. Oxidation takes place at the negative electrode in a voltaic cell and reduction takes place at the positive electrode in an electrolytic cell.

31. Consider the standard electrode potentials of the following reactions:



What is the value of the cell potential (in volts) for the spontaneous reaction?

- A. +1.69
 - B. +1.39
 - C. +0.92
 - D. +0.62
32. In the electrolysis of acidified water, if 8.4 cm^3 of hydrogen gas is evolved, what volume of oxygen gas is evolved?
- A. 4.2 cm^3
 - B. 8.4 cm^3
 - C. 12.6 cm^3
 - D. 16.8 cm^3

33. Which factors affect the amount of metal formed during electrolysis?

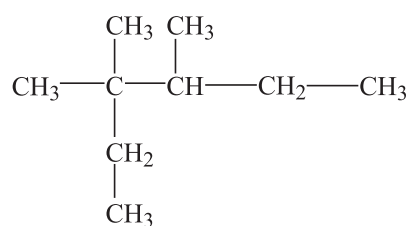
- I. Charge on the metal ion
- II. Current
- III. Time

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

34. Nylon is a condensation polymer made up of hexanedioic acid and 1,6-diaminohexane. Which type of linkage is present in nylon?

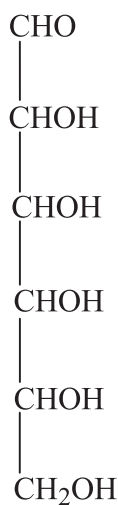
- A. Amide
- B. Ester
- C. Amine
- D. Carboxyl

35. What is the IUPAC name of the following compound?



- A. 3,3,4-trimethylhexane
- B. 3,4,4-trimethylhexane
- C. 4-ethyl-3,4-dimethylpentane
- D. 2-ethyl-2,3-dimethylpentane

36. How many chiral carbon atoms are present in a molecule of glucose?

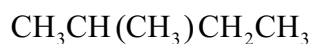


- A. 1
- B. 2
- C. 3
- D. 4
37. An organic compound **X** reacts with excess acidified potassium dichromate(VI) to form compound **Y**, which reacts with sodium carbonate to produce $\text{CO}_2(\text{g})$.

What is a possible formula for compound **X**?

- A. $\text{CH}_3\text{CH}_2\text{COOH}$
- B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- C. $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
- D. $(\text{CH}_3)_3\text{COH}$

38. What is the ratio of peak areas in the ^1H NMR spectrum of the following compound?



- A. 3 : 1 : 3 : 2 : 3
- B. 3 : 2 : 3 : 1 : 3
- C. 3 : 1 : 3 : 5
- D. 6 : 1 : 2 : 3
39. Which statement is correct with regard to a nucleophilic substitution reaction?
- A. Tertiary halogenoalkanes react slower than primary halogenoalkanes.
- B. The rate of hydrolysis is faster for $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ than for $\text{CH}_3\text{CH}_2\text{CH}_2\text{I}$.
- C. Doubling the concentration of OH^- doubles the rate of the $\text{S}_{\text{N}}2$ reaction but not the $\text{S}_{\text{N}}1$ reaction.
- D. Primary halogenoalkanes usually follow an $\text{S}_{\text{N}}1$ mechanism while tertiary halogenoalkanes follow an $\text{S}_{\text{N}}2$ mechanism.
40. The mass spectrum of a molecule $\text{C}_3\text{H}_6\text{O}$ shows major peaks at m/z values of 58, 43 and 15. Which is the most likely structural formula of this compound?
- A. $\text{CH}_3\text{CH}_2\text{CHO}$
- B. CH_3COCH_3
- C. $\text{CH}_3\text{CH}_2\text{OCH}_3$
- D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
-